Foot Care and Neuropathy

- Perform an annual comprehensive foot exam to provide foot self-care education and teach patients to identify risk factors that may be predictive of ulcers and amputation.
- Foot exams can easily be performed in primary care settings and should include use of a monofilament, tuning fork, palpation, and visual examination of the feet and lower extremities.
- A multidisciplinary approach is recommended for individuals having foot ulcers and high-risk feet, especially those with a history of prior ulcer or amputation.
- Refer patients who use tobacco or with prior lower-extremity complications to foot specialists for comprehensive preventative care and to determine a plan for life long monitoring.
- Initial screening for peripheral arterial disease (PAD) should include a claudication history and assessment of pedal pulses. Consider obtaining arterial Dopplers to obtain early diagnosis as many patients are asymptomatic.
- Patients with significant claudication, abnormal Doppler studies, or positive ankle brachial index (ABI) should be referred to a vascular specialist for assessment and treatment with medications, exercise, and surgical options as indicated.
- Identify patients with high-risk feet.
- Closely monitor high-risk feet.
- Consider peripheral vascular studies in patients with signs or symptoms of vascular compromise.
- Ulcers should respond to treatment within a month.
- Treat foot infections aggressively.
- Patients with loss of sensation in feet and lower extremities require protective footgear - i.e. shoes and socks.
- Foot ulceration is a precursor to 85 percent of lower extremity amputations in persons with diabetes.
- In 2006, 74.9 percent of BRFSS respondents stated a health care professional had checked their feet for sores or irritations at least once in the previous year.
- *Healthy People 2010 Objective 5-14's* goal is for 75 percent of adults with diabetes to receive at least one foot examination annually.

What are risk factors for ulceration?

The first step in stopping limb loss is to identify those at risk. Risk factors for ulceration are distinguishable by general or systemic considerations versus those localized to the foot and its pathology.

General or Systemic Contributions

- Uncontrolled hyperglycemia
- Duration of diabetes
- Peripheral vascular disease
- Blindness or visual loss
- Chronic renal disease
- History of circulatory disorders
- Intermittent claudication

Local Issues

- Peripheral neuropathy
- Structural foot deformity

- Trauma and improperly fitted shoes
- Callus
- History of prior ulcer/amputation
- Prolonged elevated pressures
- Limited joint mobility

What is diabetic neuropathy?

Diabetic neuropathy refers to the presence of signs and symptoms of peripheral nerve dysfunction in people with diabetes after excluding other causes, and can be motor, sensory, or autonomic. Diagnosis should be made after a thorough examination of the lower limbs including vibratory testing and use of a 5.07 monofilament. Absence of symptoms should not be assumed to indicate absence of signs. Loss of the ability to feel vibration is often the first sensation lost by diabetic patients. Confirmation of diagnosis can be confirmed by quantitative electrophysiology, sensory, and autonomic function testing.

Diabetic neuropathies are heterogeneous and affect different parts of the nervous system, and can initially present with a plethora of diverse clinical manifestations of focal or diffuse nature. Sensorimotor distal symmetric polyneuropathy (DPN) and the autonomic neuropathies are most common. DPN is considered to be a diagnosis of exclusion. According to Boulton et al (2005), early diagnosis and treatment of diabetic neuropathy is important for the following reasons:

- Nondiabetic neuropathies can be present in patients with diabetes mellitus
- Currently a number of treatment options are available
- Approximately 50 percent of patients with DPN may be asymptomatic
- Patients are at great risk of insensate injury to their feet
- > 80 percent of amputations follow a foot ulcer or injury
- Treatment includes early recognition and provision of patient education
- Appropriate foot care may result in a reduction in the incidence of ulceration and ultimately prevent future amputation
- Autonomic neuropathy may involve every system in the body
- Autonomic neuropathy causes a substantial increase in morbidity and mortality, especially if cardiovascular autonomic neuropathy (CAN) is present

What are treatment options?

The first logical step in treatment is to normalize glucose control to acceptable limits of normal. Research suggests that neuropathic symptoms may improve with control of blood sugars and avoidance or erratic excursions of hyperglycemia. Currently, a number of non-pharmacological interventions such as topical preparations (Capsaicin, glyceryl trinitrate, spray, patches, etc.), acupuncture, and physical therapy may be beneficial. Medications of benefit to patients include use of tricyclic drugs, anticonvulsants, anti-depressants (Amitriptyline, Neurontin, Lyrica, and Cymbalta), and opioid or opioid-like drugs. Referral to pain clinics may offer some benefit. Aggressive control of blood glucose, A1C, blood pressure, lipids, and healthy lifestyle changes may result in reduced incidence of injury to the feet and lower extremities.

I. Annual Comprehensive Foot Examination with Risk Stratification

The U.S. Department of Health and Human Service Monograph, *Feet Can Last a Lifetime,* includes sample patient education materials, a 5.07 Semmes-Weinstein nylon monofilament, practice management tools, and a comprehensive resource list. A brief summary of the recommendations follows.

A. Steps for Preventing Diabetes Foot Problems

1. **Perform a comprehensive foot exam annually.**
   - ❖ Examine skin, hair, toenails, musculoskeletal structure, and evaluate vascular status and protective sensation
   - ❖ Inspect footwear for proper fit, appropriate materials, foreign objects, torn linings, and proper cushioning
2. **Categorize your findings.**

Table 9: Risk Assessment of Lower Extremities

Low Risk	**Risk**
All of the following:	*One or more of the following:*
Intact protective sensation	Loss of protective sensation
Pedal pulses present	Absent pedal pulses
No foot deformity	Foot deformity
No history of foot ulcer	History of foot ulcer
No amputation	Prior amputation

3. **Document your findings in the medical record.**
4. **Counsel your patients and/or refer to a diabetes educator.**
   - ❖ Examine feet and lower extremities at each visit
   - ❖ Talk with your patients about their risk category
   - ❖ Demonstrate self-care techniques
   - ❖ Instruct patients to report injuries, trauma, or signs of infection
   - ❖ Prescribe appropriate footwear
   - ❖ Give positive feedback for proper foot care
   - ❖ Counsel about tobacco cessation if needed
   - ❖ Exercise
   - ❖ Reinforce the importance of blood glucose control to reduce the risk for foot problems and other complications (A1C reduction)
5. **Follow up with low risk patients.**
   - ❖ Visually inspect feet at every visit
   - ❖ Inspect footwear at every visit as warranted
6. **Follow up with high risk patients.**
   - ❖ Place a “high risk feet” sticker on medical record
   - ❖ Visually inspect feet at every visit
   - ❖ Inspect footwear at every visit
   - ❖ Prescribe special inserts and shoes as needed
   - ❖ Refer to specialist for a risk factor you cannot rectify
   - ❖ Use an interdisciplinary team approach to ensure positive patient outcomes (i.e. primary care physician, podiatry, surgeons, dietician, diabetes educator, home health, etc.)
   - ❖ Ensure that the elderly and blind have help for daily foot care

II. Vascular Evaluation of the Lower Extremity in a Patient with Diabetes

This section contains additional specific information on the evaluation of the arterial supply to the lower extremities.

A. History

The patient should be asked about:

- ❖ Calf, thigh, or buttock claudication
- ❖ Pain at rest in feet and toes (vascular rest pain is confined to the feet)
- ❖ Circulation to the extremities
- ❖ Previous sepsis
- ❖ Other co-morbid conditions, and
- ❖ Impaired renal function

B. Physical Examination

Identify:

- ❖ Decreased or absent peripheral pulses, i.e. femoral, popliteal, dorsalis pedis, posterior tibial
- ❖ Cool feet
- ❖ Dependent rubor
- ❖ Atrophy of subcutaneous tissues, and
- ❖ Hair loss

If there is any historical or physical suggestion of compromised blood supply to the forefoot or toes, even with palpable pedal pulses, non-invasive peripheral vascular testing should be ordered.

C. Non-Invasive Peripheral Vascular Testing

An objective assessment of the severity of peripheral arterial occlusion can be obtained by the use of one or more non-invasive diagnostic tests. Non-invasive testing is also helpful in patients with an equivocal history or physical exam. Typically, a professional with expertise in the subject will work in conjunction with the referring practitioner to determine which tests are appropriate given the specific clinical scenario.

Segmental measurement of blood pressure and Ankle Brachial Index (ABI)

Serial placement of a blood pressure cuff and Doppler auscultation allows measurement of blood pressure along the legs. Normally, blood pressures in the legs and arms are equal. In fact, ankle pressure may be slightly higher than arm pressure. The ABI is the ratio of the arterial pressure in the ankle to that in the arm. The ABI in normal individuals is > 1.0. The ABI in individuals with moderate to severe occlusive disease is < 0.7. Additionally, a drop in blood pressure of 20 mmHg or more between levels indicates disease in that arterial segment. One of the pitfalls in patients with diabetes is that calcified vessels may give falsely elevated pressures, therefore definite diagnosis via Doppler studies should be considered.

Pulse-Volume Recording (PVR)

Significant arterial occlusion decreases the normal volume displacement in the legs that occurs with each pulse and alters the waveform output of the test. Flat or barely pulsatile tracings at the ankle indicate moderately severe to severe ischemia.

Doppler Flow Velocity Waveform Analyses

The contour of the Doppler waveform is flattened with significant disease. This test gives similar information to the PVR. Monophasic flow on Doppler studies and non-healing/slow healing wounds may merit further study or referral to a specialist.

Treadmill Testing

Treadmill exercise testing allows assessment of functional limitation. Decline of the ABI after exercise supports the diagnosis of vascular occlusion if history and physical exam are equivocal. This test most frequently is used for patients with normal pulses who have symptoms of claudication to distinguish between vascular and neurogenic claudication.

D. Clinical Scenarios Using Non-Invasive Peripheral Vascular Testing

If there are any clinical signs or symptoms of peripheral vascular compromise, the patient should undergo non-invasive testing. An ABI of < 0.7 and flat or barely pulsatile PVR tracings at the ankle indicate moderately severe to severe ischemia. Treadmill testing may be helpful if initial results are normal at rest and the patient has a strong history of claudication.

If a patient is at high-risk for foot problems but does not have signs or symptoms of vascular occlusion, a non-invasive test is indicated to establish a baseline. Examples of high-risk foot conditions include the presence of abnormal foot structure or biomechanics, neuropathy, and employment that requires extensive walking or standing.

III. Management of Diabetic Foot Ulcers

Ulcers should heal. There are three core therapies of diabetic ulcers:

- Topical therapy
- Pressure reduction dressing
- Edema reduction dressing

Emerging technologies that may play a role include growth factors and artificial skin substitutes. Surgical interventions are sometimes necessary, e.g. debridement, bone resection, arthrodesis, tendon lengthening and rerouting, and skin flaps.

The presence of an ulcer or the history of a previous ulcer should stimulate an evaluation of the underlying cause and appropriate preventive management. Specific consideration should be given to the possibility of previously undetected vascular compromise.

IV. Management of Diabetic Foot Infections

All patients with diabetes should be proactively encouraged to seek early evaluation at the first suggestion of infection. Pain and tenderness are not consistent findings and should not be used to judge either the presence of infection or the progress of treatment.

A. Infection Classification

Severity of infection is based on clinical exam:

Type I (mild) infections are characterized by mild erythema of skin, minimal edema, and only minor breaks in the skin, e.g. superficial ulcer, small laceration, blister. There is no osteomyelitis or systemic toxicity.

Type II (moderate, limb threatening) infections usually surround a chronic ulcer. Ulceration extends to deep tissues but no bone is exposed. Edema may extend to the forefoot. Cellulitis is typically present. Purulent drainage and osteomyelitis may be present.

Type III (severe, limb and life threatening) infections are typically odorous and draining purulent material. Erythema, cellulitis, and lymphatic streaking are typical. There may be gangrenous, wet, black soft tissue present. Bone or joint space may be exposed. Osteomyelitis may be present. Signs and symptoms of systemic toxicity may be present.

B. Diagnosis

Physical Exam*

-Probe bone for soft areas suggestive of osteomyelitis

-Probe wound for tracking and undermining
-Document wound area and depth
-Periodically evaluate wound size and volume to gauge response to therapy
-Pain and tenderness are not consistent findings
**Practitioners unfamiliar with wound probing should consult or refer to a physician with training and experience with this assessment.*

Laboratory

-Culture purulent drainage, abscesses, and tissue from deep debridement

-Usually avoid culture of superficial lesions as these results are not particularly helpful

-Blood cultures are appropriate in serious infections
-CBC in Type II and III infections
-Renal and liver function tests if needed to guide antibiotic choice
-Sedimentation Rate (WESR) may be useful—if elevated, consider osteomyelitis

Radiology

-Acute osteomyelitis is not always identifiable by routine radiographs or CT scans, except in the late phases
-Plain radiographs may reveal soft tissue gas in deep infections
-Serial radiographs aid monitoring erosive changes in chronic lesions, and are the most useful
-Bone scans may not always be helpful in making the diagnosis of osteomyelitis (three phase is necessary)
-Bone scans are helpful in detecting a Charcot fracture, as the cause of an acutely swollen foot with no open lesion

C. Treatment

Type I infections with no evidence of peripheral vascular obstruction may be treated with outpatient oral antibiotics. The most likely organisms are Staphylococcus or Streptococcus. Patients should be seen again in 24 to 48 hours. If there is no improvement within 48 hours, hospital admission is indicated for bed rest, wound care, and intravenous antibiotics. If the patient has peripheral vascular disease, initial hospitalization and surgical consultation are recommended. Consultation with podiatry is appropriate if underlying deformity or altered biomechanics are present.

If there is no response to therapy or re-infection occurs, one should re-evaluate vascular supply, wound care, and antibiotic therapy. Consultation with an expert in the management of diabetic foot infection is also appropriate.

Type II infections necessitate in-hospital intravenous antibiotic therapy. Surgical consultation is indicated for drainage, debridement, and culture. Infectious disease consultation is appropriate. Type II and III infections are typically polymicrobial (gram negative rods, anaerobes, and enterococci).

Type III infections are a surgical emergency. Immediate surgical drainage and/or amputation is necessary. Infectious disease consultation is appropriate. Type II and III infections are typically polymicrobial (gram negative rods, anaerobes, and enterococci).

Please refer to Figures 3 and 4 and Table 10 on the following pages.

Figure 3: Diabetic Foot Ulceration Associated with Diabetes
Vascular disease, neuropathy, and mechanical trauma are common pathologies seen in patients with diabetes mellitus, and are responsible for complications such as ulceration and amputation.

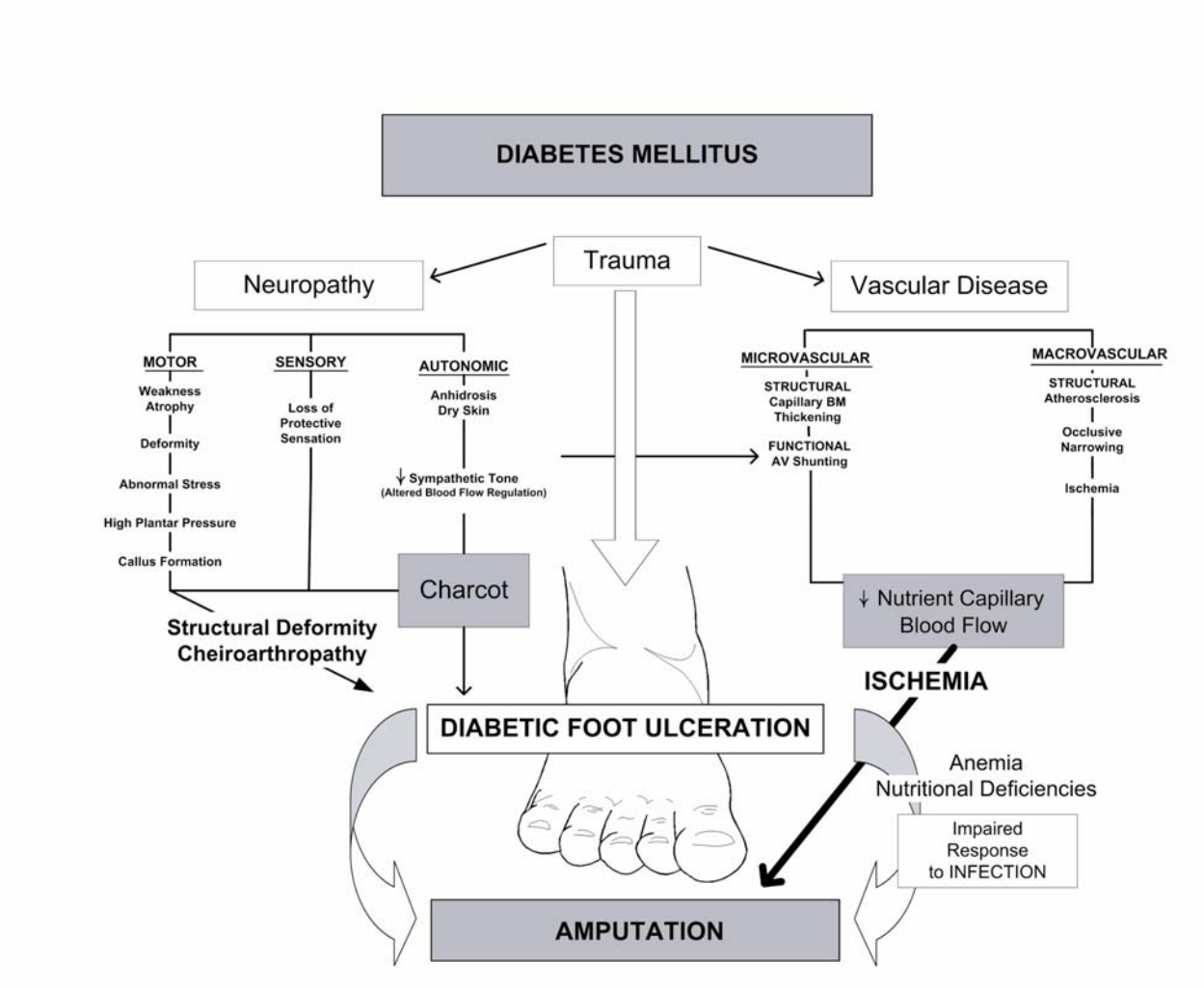

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Figure 4: Diabetic Foot Disorders

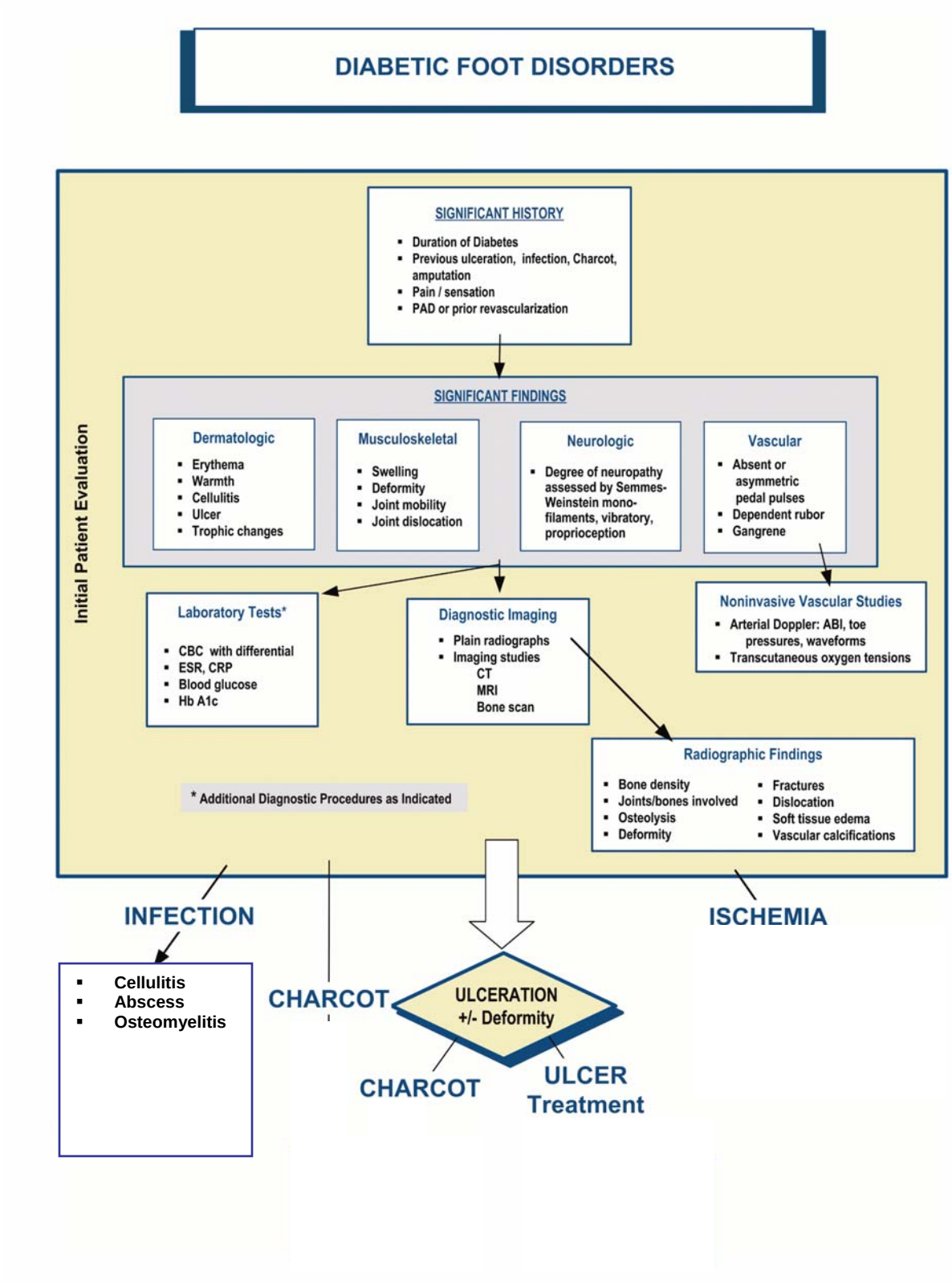

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Table 10: Lower Extremity Diabetic Foot Exam

Examination

- Palpation of pulses—common femoral, popliteal, dorsalis pedis, and posterior tibial
- Handheld Doppler examination
- Skin/limb color changes—cyanosis, erythema, elevation pallor, and dependent rubor
- Presence of edema
- Temperature gradient (ipsilateral and contralateral extremity)
- Dermal thermometry
- Integumentary changes—skin atrophy (thin, smooth, parchment-like skin), abnormal wrinkling, absence of hair growth, onychodystrophy
- Previous hospitalizations/surgery

Neurologic Examination

- Vibration perception—tuning fork 128 cps and measurement of vibration perception threshold (biothesiometer)
- Light pressure—Semmes-Weinstein 5.07gram monofilament
- Light touch: cotton wool
- Two point discrimination
- Pain: pinprick (sterile needle)
- Temperature perception: hot and cold
- Deep tendon reflexes: patella, Achilles
- Clonus testing
- Babinski test
- Romberg test

Footwear Examination

- Type of shoe (athletic, oxford, comfort, etc.)
- Fit and depth of toe box
- Shoewear, patterns of wear
- Lining wear
- Foreign bodies
- Insole, orthoses

Dermatologic Examination

- Skin appearance—color, texture, turgor, quality, dry skin
- Calluses—discoloration/subcallus hemorrhage
- Fissures (especially posterior heels)
- Nail appearance—onychomycosis, dystrophic, gryphotic, atrophy or hypertrophy, paronychia
- Hair growth
- Ulceration, gangrene, infection—note location, size, depth, infection status, etc.
- Interdigital lesions
- Tinea pedis
- Markers of diabetes—shin spots (diabetic dermopathy), necrobiosis lipoidica diabeticoroum, bullosum diabeticoroum, granuloma annulare, Acanthosis Nigricans

Musculoskeletal Examination

- Biomechanical abnormalities
- Structural deformities—Hammertoe, bunion, tailor's bunion; Hallux limitus/rigidus; flat or high-arched feet; Charcot deformities; and postsurgical deformities (amputations)
- Prior amputation
- Limited joint mobility
- Tendo-Achilles contractures/equinus
- Gait evaluation
- Muscle group strength testing—passive and active, non-weight bearing and weight bearing, foot drop, atrophy—intrinsic muscle atrophy
- Plant pressure assessment—computerized devices, Harris ink mat, pressure sensitive foot mat

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